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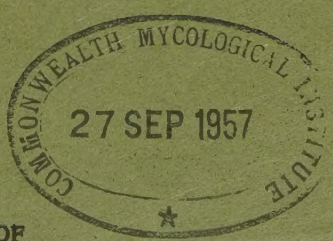
CENTRAL RICE RESEARCH INSTITUTE, CUTTACK

Survey

ANNUAL REPORT

FOR

1953-54.



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CENTRAL RICE RESEARCH INSTITUTE, CUTTACK.

Annual Report for 1953-1954.

Season and Crop conditions.—The 1953-54 season was favourable and crop conditions were very satisfactory, as a result of which yields obtained were very good. The monsoon started normally about the middle of June and the total precipitation of 46·65 inches recorded during the year, though about 17 per cent. less than the average annual rainfall, was well distributed throughout the main crop season. The distribution of the rainfall during the year as compared to the average of 10 years is given in Table I. The rainfall during the winter months was deficient.

TABLE I.

Rainfall in inches.

	Average of 10 years (1940-49).	1953-54.
S. W. Monsoon—		
June	6·88	5·30
July	15·41	8·36
August	12·49	15·69
September	7·77	5·53
	42·55	34·88
Post Monsoon—		
October	7·10	3·93
November	1·65	4·08
	8·75	8·01
Winter—		
December	0·51	0·00
January	0·48	0·00
February	1·00	0·72
	1·99	0·72

TABLE I—*contd.*

Rainfall in inches—contd.

	Average of 10 years (1940-49).	1953-54.
Summer or Pre-monsoon—		
March	0·79	0·00
April	1·29	0·93
May	1·43	2·12
	3·51	3·05
TOTAL	56·80	46·66

AGRONOMY.

A.—Varietal Trials.

Ninety five varieties carried forward from last year's trials were grouped according to maturity periods and tested for yield performance in the main crop season. In the second crop season 36 varieties were tested and the suitablility of 88 other varieties was studied in observation plots. Besides these, a co-operative trial with 15 Chinese and improved indigenous varieties was conducted at 20 locations in different rice growing states.

(i) The 85-100 days duration trial was conducted this year under both transplanted and dibbled conditions with the same varieties as last year *i.e.*, eight Chinese, six improved strains, including the new selection B. 76—1, against the standard *Benibhog*. The results obtained were different under the two conditions but variety PTB. 10 gave significantly better yield than *Benibhog* under both the conditions. As reported, this variety yielded significantly more than *Benibhog* last year also. Varieties B. 76—1 and Adt. 4 gave increased yield over the control but the differences were not significant. The Chinese varieties Ch. 63, Ch. 47 and Ch. 41 gave better performance under dibbled conditions yielding 21,13 and 12 per cent. higher than the control respectively. The average yield in case of the dibbled crop was about 69·4 per cent. of the transplanted crop.

(ii) In 110-125 days duration trial, 28 varieties were tested. None of these types were superior to the control, T. 635, which yielded 2,489 lb. per acre and has proved superior for the past three seasons.

(iii) In 125-145 days duration trial, 18 varieties were tested with SLO. 6 as standard. Seven varieties gave higher yields than control and two of these *viz.*, BK. 6 and T. 874—1—9—2 were significantly superior to the standard and yielded 28·7 and 20·7 per cent. better. During the last season also these varieties had given similar performance.

(iv) In 150-160 days duration trial, 20 varieties were tested against standard T. 1242. The yield differences were not significant, but BAM. 9 maintained its superiority and gave 222 lb. higher yield per acre than the control.

(v) In very late duration trial (over 170 days), twelve varieties were tested against T. 1242. Variety Co. 19, which was found superior last year, has given a good performance this year also, yielding 20 per cent. higher than the control. Another variety, AKP. 11, yielded 16·8 per cent. higher than the control.

(vi) In the second crop season trial, 36 short duration varieties were tested against PTB. 10 as control. Seven varieties *viz.*, Co. 10, Ch. 64, Ch. 4, Ch. 41, Ch. 63, Ch. 43 and Ch. 47 proved significantly superior to the control by 26-33 per cent. The performance of these 7 varieties and the control is given in Table II. Some of the Chinese varieties appear to be well suited for the conditions prevailing in the second crop season.

TABLE II.

Second crop season trial, performance of 7 promising varieties as compared to the control.

Variety.	Yield of of paddy lb./Acre.	Percentage on control.	Remarks.
Co. 10	2,504	133·3	
Ch. 64	2,483	132·2	
Ch. 4	2,476	131·8	
Ch. 41	2,414	128·5	Varieties Ch. 64 to Ch. 47 are of Chinese origin.
Ch. 63	2,387	127·1	
Ch. 43	2,380	126·7	
Ch. 47	2,373	126·3	
PTB. 10 (Control) . .	1,878	100·0	

C. $D._{05}$=431 lb.

(vii) *Co-operative varietal trial.*—In order to determine the suitability of some introductions and improved indigenous varieties under different soil and climatic conditions, the performance of 13 varieties, consisting of eight Chinese, two varieties from Cuttack and three Madras varieties were tested against two local improved strains in a co-operative trial at 20 centres in nine rice growing states. This was the second year of the trial. The pooled yield data for the two years (1952-53 and 1953-54) showed that the performance of Ch. 62, Ch. 63 and Ch. 45 (Chinese varieties), PTB. 10 (Madras) and B. 76—1 (Cuttack) was satisfactory, particularly in the states of Bihar, Orissa and Bombay. The reports from the various centres also indicate that the Chinese varieties can withstand adverse climatic conditions.

B.—Manurial Trials.

Efficiency of nitrogenous fertilizers for rice.—This experiment has been in progress for the last four years. During the current season, three more nitrogenous fertilizers *viz.*, ammonium sulphate-nitrate, Sodium nitrate and Calcium Cyanamide were included in the trial. All these fertilizers were tested at the levels of 20 and 40 lbs. N. per acre on a medium duration variety T. 141. The results are presented in Table III.

TABLE III.

Comparative efficiency of various nitrogenous fertilizers—yield of paddy in lb. per acre.

Fertilizer Forms.	Nitrogen level N. lb./Acre.			C. D. (·05) for Form means.
	20	40	Mean (Forms).	
1. Ammonium Sulphate-Nitrate .	3,102	3,021	3,062	255·42
2. Ammonium Nitrate . . .	2,932	2,627	2,780	
3. Ammonium Sulphate . .	2,844	2,600	2,722	
4. Ammonium Phosphate . .	2,839	2,466	2,652	
5. Sodium nitrate . . .	2,834	2,982	2,908	
6. Ammonium Chloride . .	2,562	2,367	2,465	
7. Calcium cyanamide . .	2,508	2,707	2,608	
8. Urea	2,291	2,440	2,366	
9. No manure (control) . .	2,799		2,799	
Mean (levels)	2,739	2,651	..	

In general the response to fertilizer application was low and there was no significant difference between the levels of nitrogen application. Yield differences due to various forms of nitrogenous fertilizers were however, significant. Comparing the yields obtained at 20 lb. N. per acre, it is seen that application of the double fertilizer, ammonium sulphate-nitrate, gave the highest yield, *i.e.*, 3102 lbs. per acre, which was significantly superior to other forms except ammonium nitrate. This fertilizer has been tested for the first time during the season. Urea has given the lowest yield.

(ii) *Residual effect of nitrogenous fertilizers.*—The area last year under the experiment on efficacy of different nitrogenous fertilizers was uniformly cropped this season with variety T. 141 in order to investigate if there was any residual effect of the fertilizers. As in last year the results showed that none of the nitrogenous fertilizer have any residual effect.

(iii) *Placement and split application of ammonium sulphate for rice crop.*—This experiment was started last year with a view to study the effect of the placement of fertilizer in split doses at different stages of plant growth. This year the experiment was conducted under only low lying conditions with late

maturing variety T. 1242 and the same treatments as last year. The yields obtained are given in the following Table IV.

TABLE IV.

Yield of grain in lb. per acre.

Treatments.	Nitrogen level— lb. per acre.		Mean.
	20	40	
1. No manure (control)	2,573		2,573
2. Surface application at planting	3,189	3,230	3,210
3. Surface application one month after planting .	2,978	3,176	3,077
4. Sub-surface 'dry' application (before planting) .	2,862	3,494	3,178
5. Sub-surface pellet application at planting . .	3,355	3,315	3,335
6. Sub-surface pellet application one month after planting.	3,039	3,407	3,223
7. ½ Sub-surface dry + ½ surface one month after .	3,001	3,422	3,212
8. ½ Sub-surface dry + ½ pellet one month after .	3,308	3,315	3,312
9. ½ Surface at planting + ½ surface one month after.	3,254	3,474	3,364
10. ½ Surface at planting + ½ pellet one month after .	3,095	3,434	3,265
11. ½ Surface at planting + ¼ one month after + ¼ before flowering.	..	3,496	3,496
12. ½ Sub-surface dry+ ¼ one month after+ ¼ before flowering.	..	3,375	3,375
13. ½ Sub-surface dry+ ¼ pellet one month after+ ¼ pellet before flowering.	..	3,635	3,635
Mean	3,120·1	3,397·1	—

C. D. (·05) to compare level means. . . . . 109·2

C. D. (·05) to compare individual treatments . . . 327·2

Ammonium sulphate application has given a good yield response and shows linear trend upto 40 lb. N. per acre.

Unlike last year the application of ammonium sulphate in split doses has given a better yield response than the entire quantity applied in one dose. The best yields were obtained with sub-surface application of half the quantity of ammonium sulphate before planting, followed by ¼th quantity one month after planting and remaining ¼th just before flowering in the form of pellets placed at the root zone to supply total quantity of 40 lb. nitrogen per acre.

The yield response obtained with fractional application of ammonium sulphate averaged over the method of application are presented in Table V.

TABLE V.

Yield response to ammonium sulphate in lb. per acre.

Treatments.	Nitrogen level—lb.per acre.	
	20	40
1. Single application—Entire quantity applied in one dose at planting.	562	773
2. Single application—Entire quantity applied one month after planting.	436	719
3. Fractional application in two doses—½ at planting *plus* ½ one month after.	615	804
4. Fractional application in three doses—¼ at planting *plus* ¼ one month after planting *plus* ½ at flowering.	..	929

(iv) *Combination of organic (compost) and inorganic (ammonium sulphate) fertilizer.*—The object of this experiment is to investigate the effect of applying vraying doses of compost alone and with ammonium sulphate as top dressing in varying doses. The experiment this year was carried out with the same layout and treatments as previously reported and late duration variety T. 1242 was grown. Both compost and ammonium sulphate application gave significantly increased yields. While in case of compost application the increasing yields were obtained upto 60 lb. nitrogen per acre, with ammonium sulphate the increasing responses were obtained upto 30 lb. N per acre, the maximum level of N tried under Ammonium sulphate. The interaction between the two was not significant. The results obtained are given in Table VI. below.

TABLE VI.

Yield in lb. per acre.

Nitrogen level lb./Acre.		Ammonium sulphate (top dressing)				C.D. (·05)
		0	15	30	Mean.	
Compost (Basal dressing).	0	3,079	3,484	3,791	3,451	245·0
	30	3,370	3,654	3,808	3,610	
	60	3,546	3,689	3,962	3,732	
	90	3,637	3,803	3,842	3,760	
	Mean	3,408	3,657	3,850		
	C.D. (·05)	207·7				

(v) *Combination of organic (green manure) and inorganic (Ammonium sulphate) fertiliser.*—With the object to compare the relative efficiency of green manuring and ammonium sulphate, four levels of nitrogen 0, 10, 20 and 30 lb. per acre as basal dressing of *dhanicha* green leaf and top dressing of ammonium sulphate were applied singly and in combination. The treatments were randomised in four blocks as in the previous years and late duration variety T. 90 was grown.

Both green manuring and ammonium sulphate have given similar yield responses. The increasing yields have been obtained upto 20 lb. N per acre but the differences are significant only upto 10 lb. N per acre. Though the interaction between green manuring and ammonium sulphate application is not statistically significant, the results do indicate that at lower levels of applications the responses are additive. The results obtained are given in Table VII.

TABLE VII.

Yield in lb. per acre at different levels of N in the form of green manure, ammonium sulphate and combination of two.

—	Levels of N.	Green manure (Basal dressing).				Mean.
		0	10	20	30	
Ammonium sulphate (Top dressing).	0	2,429	2,792	2,984	3,118	2,831
	10	2,658	2,965	3,123	3,244	2,998
	20	2,939	3,103	3,254	3,146	3,111
	30	3,016	3,228	3,313	3,220	3,194
	Mean.	2,761	3,022	3,169	3,182	

C. D. ·05 for marginal means=158·4.

C. D.·05 for individual means=316·8.

Long range manurial experiments.—These experiments, as previously reported, are designed to investigate the cumulative effect of continuous application of various fertilizers and manures on the condition and productivity of rice soils. Soil studies are being gradually undertaken as laboratory facilities are being available.

(a) *Ammonium sulphate, with and without lime and compost.*—This experiment, with certain modifications as reported last year, was continued on the

same site for the sixth year in succession. The results obtained are given in Table VIII.

TABLE VIII.

Yield of grain in lb. per acre. (Variety T. 1145.)

Basal dressing Lime cwt. acre.	Ammonium sulphate. Nitrogen lb./acre.								
	No compost.				Compost at 100 mds./ Acre.				
	N_0	N_{20}	N_{40}	Mean.	N_0	N_{20}	N_{40}	Mean.	
L_0	2,234	3,006	3,211	*2,816*	3,019	3,157	3,255	*3,143*	*2,979*
L_4	2,278	3,001	3,175	*2,817*	2,985	3,001	2,105	*3,030*	*2,923*
L_8	2,380	2,900	3,401	*2,894*	3,019	3,448	3,127	*3,197*	*3,047*
Mean	2,297	2,969	3,262	..	3,007	3,202	3,163	..	..

Lime application, either alone or in conjunction with ammonium sulphate or compost, has no effect on the yield of rice as seen from the above Table.

Both ammonium sulphate and compost have given significant increase in the grain yield. Compost has given response corresponding to 20 lbs. N applied as ammonium sulphate. The interaction between ammonium sulphate and compost is significant. While in absence of basal dressing of compost, the ammonium sulphate gave linear response upto 40 lb. N/A, with basal dressing of compost, the yield increased only upto 20 lb. N per acre, and with further increase in level of nitrogen there was no increase in yield. The yield data averaged over the lime treatments are presented in Table IX.

TABLE IX.

Yield of grain in lb. per acre. (Variety T. 1145.)

Basal dressing of compost mds./ acre.	Top dressing of ammonium sulphate— lb./N acre.			Mean.
	N_0	N_{20}	N_{40}	
C_0	2,297	2,969	3,262	2,843
C_{100}	3,007	3,202	3,163	3,124
Mean	2,652	3,086	3,213	..

C. D. (·05) for comparing compost means	135
C. D. (·05) for comparing ammonium sulphate means	172
C. D. (·05) for comparing two compost mean within the same nitrogen level.	415
C. D. (·05) for comparing the two nitrogen levels within the same level of compost.	243

(b) *Ammonium sulphate with and without compost.*—This experiment has been in progress for the past five years. The results obtained this year are presented in Table X.

TABLE X.

Yield in lb. per acre. (Variety. T. 1145.)

Top dressing of ammonium sulphate N/A.	Basal dressing of compost mds. per acre.		Mean.
	C_0	C_{100}	
N_0	2,162	2,854	2,508
N_{20}	2,729	3,288	3,009
N_{40}	3,232	3,245	3,239
N_{60}	3,272	3,056	3,164
N_{80}	3,103	2,362	2,688
Mean	2,882	2,961	..

C. D. (·05) for comparing compost mean . . . . . 262·8

C. D. (·05) for comparing nitrogen mean . . . . . 415·2

C. D. (·05) for comparing nitrogen level at the same level of compost . 436·4

C. D. (·05) to compare two compost levels at the same level of nitrogen 455·0

The effect of ammonium sulphate levels was highly significant, as also its interaction with basal dressing of compost. While in absence of basal dressing the yield increased upto 40 lb. N. per acre, with the basal dressing of compost the yield increased only upto 20 lb. N/A. In both cases there was progressive reduction in yield with increasing doses of ammonium sulphate beyond the optimum dose. Compost alone gave a yield response which corresponds to 20 lb. N/A as ammonium sulphate. The yield nitrogen level relationship in both the cases can be represented by the quardratic curve and is given by the following equation.

C_0 $Y = 2132{\cdot}85 + 826{\cdot}25\,X - 150{\cdot}53\,X^2$

C_{100} $Y = 2862{\cdot}69 + 564{\cdot}93\,X - 171{\cdot}68\,X^2$

Where, Y is the mean yield per acre and X is the nitrogen level per acre, each unit being of 20 lb. N/A. From the yield—nitrogen quadratic function, the estimated maximum yield will be 3,327 and 3,267 lb. per acre corresponding to 33 and 55 lb. N. per acre respectively without and with compost.

Effect of the continuous application of ammonium sulphate on the productivity of the soil.—In the above experiment the ammonium sulphate at various levels

has been applied to the same plots for the past five years. The yields for the past five years are given in the following Table :—

TABLE XI.

Grain yield in lb. per acre.

Treatments.							Mean.
Basal Dressing mds./A.	Top Dressing N/A.	1949-50	1950-51	1951-52	1952-53	1953-54	
C_0	N_0	1,532	2,152	1,988	1,864	2,162	1,940
	N_{20}	1,624	2,524	2,339	1,919	2,729	2,227
	N_{40}	1,987	2,746	2,395	2,099	3,232	2,492
	N_{60}	1,906	2,547	2,355	2,287	3,272	2,473
	N_{80}	1,683	2,463	1,999	2,110	3,013	2,254
C_{100}	N_0	1,743	2,264	2,319	2,052	2,854	2,246
	N_{20}	1,896	2,778	2,361	2,419	3,288	2,548
	N_{40}	2,102	2,624	2,155	2,328	3,245	2,491
	N_{60}	1,889	2,087	2,077	2,222	3,056	2,266
	N_{80}	1,374	2,024	1,364	1,702	2,961	1,765
	Mean	1,774	2,421	2,135	2,100	2,922	2,270

The pooled analysis of variance of the five years show that the seasonal variation of yield was significant, but neither the interaction of seasons with ammonium sulphate nor with compost application was significant. The data also indicate that trend of yield with various doses of ammonium sulphate was same from year to year. Therefore it is obvious that there has been no deleterious effect due to the application of ammonium sulphate during the period of experiment.

(c) *N, P, K. Experiment.*—This experiment, now in its 5th year, is designed to investigate the suitable combination of the major plant nutrients N, P and K and their comparative performances with the basal dressings of various organic manures. As in previous years, the fertilizers were applied at three levels *viz.*, 0, 20, and 40 lb. of N, P_2O_5 and K_2O in various combinations with the basal dressings of various organic manures to supply nitrogen at 20 lb. per acre. The data are presented in the following table :—

TABLE XII.

Top dressing of ammonium sulphate lbs./A.	Basal dressing of organics.				Mean.
	No manure.	Compost.	Groundnut cake.	*Dhaincha.*	
0 . . .	2,091	2,282	2,121	2,442	2,234
20 . . .	2,108	2,334	2,109	2,439	2,248
40 . . .	2,270	2,512	1,820	2,440	2,260
Mean . . .	2,156	2,376	2,017	2,440	

Green manuring and compost application increased the yield by 284 lb. and 220 lb. per acre respectively, though these differences were not significant. Groundnut cake application does not show any effect on the yield. Unlike previous year, Ammonium Sulphate application has not given any yield response but it shows significant interaction with compost, and when applied at the rate of 40 lb. N. per acre in conjunction with compost it gave the highest response viz., 421 lb. per acre. As in the previous years neither phosphate nor potash had any effect on the yield as seen from the following table :—

TABLE XIII.

Yield of grain in lb. per acre. (*Variety T.* 1145.)

—	K_0	K_{20}	K_{40}	Mean.
P_0	2,346	2,248	2,179	2,258
P_{20}	2,260	2,267	2,287	2,271
P_{40}	2,174	2,216	2,254	2,214
Mean	2,260	2,244	2,240	

C.—Cultural Trials.

(i) *Crop sequence experiment.*—The previous year's finding that the inclusion of groundnut crop in sequence with rice benefits the succeeding rice crop, besides giving a good economic return was further confirmed this year. The rice crop following groundnut crop yielded 2,634 lb. per acre, while the rice crop following rice crop yielded only 2,358 lb. per acre.

The scope of the experiment was further enlarged and besides groundnut other crops, *e.g.*, cotton, wheat, gram, mustard, linseed and *mung* were included. The first crop of rice was harvested during the 1st week of October and the various rotational crops were sown in the last week of October, 1953. The data regarding the various crops are presented in the following table :—

TABLE XIV.

Yield of various crops in lb. per acre.

Crop.	Variety.	Date of sowing.	Date of harvesting.	Yield in lb. per acre.
1. Rice	PTB. 10	8-12-53	8-4-54	1,823
2. Groundnut	T. 685	22-10-53	21-4-54	1,172
3. Gram	T. 87	22-10-53	18-3-54	1,217
4. *Mung*	U. P. No. 1	22-10-53	8-1-54	476
5. Cotton	F. 216	22-10-53	31-5-54*	896
6. Wheat	N. P. 761	22-10-53	24-2-54	444
7. Linseed	R. R. 40	22-10-53	4-3-54	274
8. Mustard	Local	22-10-53	13-1-54	205

*Last picking.

These crops will be followed by rice during the next main crop season to determine the effect of these crops on the yield of subsequent rice crop.

(ii) *Herbicides for weed control in rice fields.*—The experiment to determine the efficiency and the optimum time of spraying of various herbicides for control of weeds in rice fields, and to study their ultimate effect on the rice yield, started last year, was continued with the inclusion of two additional treatments *viz.*, Calcium cyanamide and Hand weeding. Calcium cyanamide was applied before planting at the rate of 300 lb. per acre. The results obtained are given in the following table :—

TABLE XV.

Treatments.	Yield of grain in lb. per acre.	Percentage on control.
No weeding (control)	3,646	100·0
Hand weeding	3,843	105·4
Calcium cyanamide	3,285	90·1
Chloroxone at 2 lb. acid/Acre. Pre-planting.	3,753	102·9
Phenoxylene 30 at 2/3 gallon acre Pre-planting	3,789	103·9
2, 4, 5-T at 1 lb./Acre Pre-planting	3,833	105·1
Choroxone at 2 lb. acid/Acre Post-planting	4,024	110·3
Phenoxylene at 2/3 gallon/acre Post-planting	4,199	115·1
2, 4, 5-T at 1 lb./Acre Post-planting	3,790	103·9
S. E. for the mean	122·3	..
C. D. ·05	356·7	..

The yield differences were found to be significant. The application of calcium cynamide does not seem to have any beneficial effect and has depressed the yield. The application of Phenoxylene 30 (M.C.P.A.) at 2/3 gallon/Acre and Chloroxone (2, 4-D) at 2 lb./Acre sprayed 4-6 weeks after planting were found to be the most effective and gave significantly higher yields while hand weeding came next.

D.—Cultural-cum-Manurial Trials.

In order to test the merits of various operations recommended under the Japanese method of rice cultivation, a 2^6 confounded experiment was conducted during the year as per co-ordinated plan drawn by the Indian Council of Agricultural Research. The following six treatment combinations were included in the trial :—

Treatments.	Japanese method.	Local recommended method.
i. Seed rate . . .	p-20 lb. per acre . . .	p_0-30 lb. per acre.
ii. Nursery preparation and manuring.	q-a) 4′ wide raised seed bed .	q_0-Flat seedbed.
	(b) Application of manure and fertiliser to nursery for planting an acre. Compost. 2,400 lbs. Am. Sulpht. 20 lbs. Super. Phos. 20 lbs.	Only compost applied at 2,000 lb. to nursery for planting an acre field.
	(c) Sifting of seed and dipping in 18 per cent. brine solution.	
	(d) Treated with agroson at the rate of 1 lb. for 400 lb. seed.	
iii. No. of seedlings per hole.	r-4 seedlings per hole . .	r_0-3-4 seedlings per hole.
iv. Method of transplanting.	s-Transplanted in straight lines with 10″ spacing allround.	s_0-Bulk planting 6″-8″ apart.
v. Field manuring . .	t-(a) Basal dressing at the rate of 2½ tons of compost and 6,000 lb. green leaf per acre.	t_0-Basal dressing of 2½ tons of compost per acre at planting time.
	(b) Sub-surface application at the rate of 100 lb. ammon. sulphate *plus* 100 lb. super phosphate per acre at planting.	
	(c) Top dressing at the rate of 100 lb. ammonium sulphate *plus* 100 lb. super phosphate per acre applied one month after planting.	
vi. Inter culturing and weeding.	u-Hoeing and interculturing with Japanese weeder thrice.	u_0-Hand weeding twice.

The crop condition was satisfactory. The plot receiving field manuring according to the Japanese method lodged severely and consequently gave a low yield.

The analysis of variance of the grain yield data show that only two main effects, *i.e.*, field manuring and interculturing were statistically significant. The field manuring according to the Japanese method reduced the yield, while interculturing according to Japanese method increased the yield. None of the interactions were found to be significant. The average yields of grain and straw for the six main effects, averaged over other factors, are given in table XVI.

TABLE XVI.

Treatments.	Grain yield in lb. per acre.		Straw yield in lb. per acre.	
	Japanese method.	Local method.	Japanese method.	Local method.
Seed rate	3,945	4,056	9,608	9,326
Nursery preparation and manuring.	3,986	4,016	9,458	9,476
Seedlings per hole . . .	4,010	3,974	9,651	9,284
Method of planting . . .	4,013	3,971	9,326	9,629
Field manuring	3,744	4,363	9,484	9,450
Interculturing and weeding . .	4,164	3,943	9,632	9,303
Mean	3,977	4,054	9,527	9,075

(ii) *Krishi Pandit Experiment.*—At the instance of Indian Council Agricultural Research a trial was conducted to compare the cultural and manurial practices followed by Rice Krishi Pandit (1950-51), Shri K. Vellaiya Gounder of Village Thattampatti of Madras State, with the recommendations given by the Agricultural Departments. For this a small, well drained plot of 18 cents area was selected and devided into two equal sub-plots. One of the sub-plots was cultivated according to the practices followed by the Krishi Pandit and another cultivated according to recommended practices. A medium duration variety T. 141 was planted in both the plots.

The cultural and manurial practices followed under the two methods and the yields obtained are given below.

—	Krishi Pandit Method (1950-51).	Recommended practices.
A. Preparatory tillage .	8 dry ploughings . . .	4 ploughings.
B. Manuring . .	Green leaf at the rate of 5½ tons/acre.	2½ tons/acre.
	Compost at 15 tons/acre . Bone meals 500 lbs. /acre	
	Ammonium sulphate 1st dose 125 lb./acre. Ammonium sulphate 2nd dose-125 lb./acre. Ammonium sulphate 3rd dose-125 lb./acre. } 375	Super phosphate—200 lb./acre Ammonium sulphate 150 lb. acre in one dose, one month. after planting.
C. After cares . .	Interculturing & weeding thrice.	Two weedings and intercultur ings.

The following yields of grain and straw were obtained :—

—	Krishi Pandit.	Reccommended method.
Grain yield in lb. per acre	3,428	3,974
Straw yield in lb. per acre	5,506	7,148

In Krishi Pandit Plot, the crop had prematurely lodged which affected the grain setting and resulted in poor yield. The Krishi Pandit method has depressed the yield to the extent of 546 lb. per acre. The results obtained here correspond to the general conclusion that heavy application of manures and fertilizers beyond 40 lb./acre does not give any further increase in yield.

E. Simultaneous Trials.

As a measure of coordination between the various Central Institutes, it has been decided to conduct coordinated trials simultaneously at different Institutes, to test the results under different climatic and soil conditions. During the year, two varietal trials with improved N. P. Wheat and linseed varieties were conducted at this Institute in cooperation with the Indian Agricultural Research Institute, New Delhi. The results of these experiments are given below.

(i) *Wheat varietal trial.*—Fourteen improved N. P. wheats were tested in a replicated yield trial and the results are given in the following table :—

TABLE XVII.

Variety.	Yield in lb. per acre.
N.P. 718	1,746
N.P. 798	1,662
N.P. 710	1,410
N.P. 721	1,372
N.P. 799	1,364
N.P. 52	1,351
N.P. 745	1,301
N.P. 755	1,227
N.P. 760	1,204
N.P. 737	1,135
N.P. 761	1,033
N.P. 771	978
N.P. 775	908
N.P. 165	770
Mean	1,247·2
S.E.	139·8
C.D. (·05)	427·1

As wheat is not commonly grown in this area, no local variety of wheat could be included in the trial. Amongst the 14 varieties tested, varieties N. P. 718 and N. P. 798 gave significantly higher yields. The trial will be continued next year.

(ii) *Linseed varietal trial.*—Twelve improved varieties from Indian Agricultural Research Institute were tested in the yield trial replicated four times. The yields are presented in the following table :—

TABLE XVIII.

Yields of linseed in lbs. per acre.

Variety.	Yield in lb. per acre.
R.R. 38	496
R.P. 9	392
R.R. 435	338
R.R. 204	332
R.R. 432	321
R.R. 431	321
R.R. 439	310
R.R. 440	305
R.R. 40	383
R.R. 45	278
R.R. 402	234
R.R. 5	229
S.E.	37·03
C.D. (·05)	106·80

Variety R. R. 38 has given the best yield. These will be further tested next year.

BOTANY.

I. Maintenance and study of genetic stocks.

During the year 259 Foreign and Indian rice varieties were added to the collection of genetic stocks. The Foreign rices, comprising of 57 varieties, were received from Brazil, Ceylon, Egypt, French Sudan, Japan, Madagascar, Malaya and U.S.A. In response to requests from abroad and states in India seed samples of 340 varieties were supplied by the Institute.

The morphological and grain characters of the types were checked and the variation with regard to ear bearing tillers, plant height and panicle length

within the different durations was noted and is presented below.

—	Ear bearing tillers.	Plant Height (cms.)	Panicle length (cms.)
Early *indicas* (upto 120 days)	4·6— 11·4	58·2—145·7	13·1— 25·2
Medium *indicas* (121-150 days)	5·2— 16·2	64·2—210·6	20·4— 35·3
Late *indicas* (151-180 days)	4·6— 19·6	77·6—177·5	20·1— 37·0
Very late *indicas* (above 180 days)	6·2— 26·2	177·2—157·0	16·8— 27·6
Japonicas	1·8— 5·2	58·7— 84·0	13·1— 26·2
Glaberrimas	8·0— 9·4	89·0—119·0	19·9— 25·4

The search for non-lodging varieties was continued and 7 types from the collection were selected for observation of their performance under heavily manured conditions next year.

Central Rice Research Institute, Cuttack is one of the Worlds Centres for the maintenance of *indica* and *bulu* rice genetic stocks registered by the various rice growing centres with the F.A.O., with the Director in charge of the arrangements for the maintenance of both *japonica* and *indica* stocks in four centres in the world, i.e., Japan and U.S.A. for *japonica* and India and Indonesia for *indicas*.

The collection of genetic stocks at the Institute is being sifted from the point of view of yield, and based on preliminary observations 84 types were chosen for trials in the coming season.

II. Improving yield by—

(i) *Introduction.*—A preliminary study of the yield performance of 179 types, consisting of one variety each from Indochina, Ceylon, Swaziland and Russia, two each from Australia and Philippines, three each from Thailand and U.S.A., five from Malaya, nine from East Pakistan, 11 from Burma, 17 from China and 116 from India, which were selected during the previous season from the genetic stocks, was carried out in 8 replicated randomised trials arranged according to durations as given below.

(*a*) 91-100 days duration trial consisting of 8 types and control.
(*b*) 101-110 „ „ 19 „
(*c*) 111-120 „ „ 14 types and 2 controls.
(*d*) 121-130 „ „ 11 types and control.
(*e*) 131-140 „ „ 9 „
(*f*) 141-150 „ „ 48 „
(*g*) 151-160 „ „ 35 „
(*h*) 161-170 „ „ 35 „

In four of the above trials *i.e.*, 91-100, 121-130, 141-150 and 151-160 days, none of the types were found significantly superior in yield than the respective controls. However, it may be mentioned that variety *Dudhadhan* (A.C. 2117) from Uttar Pradesh, tested in the 91-100 days trial, was found to be a week earlier maturing and slightly better (2 per cent) in yield than the control *Benibhog*.

In the remaining trials 7 types *i.e.*, three varietes (A.C. 1368 from China, A.C. 2259 from Bombay, A.C. 2150 from Ceylon) in the 101-110 days duration group, one variety (A.C. 1977 from Uttar Pradesh) in the 111-120 days trial, one variety (A.C. 2960 from Burma) in the 131-140 days duration group and two varieties (A.C. 2732 and A.C. 2589) in the 161-170 days duration trial obtained from Madras, proved significantly superior to the respective controls. The variety A.C. 2960 in the 131-140 days trial, though superior in yield to the control (T. 1145) was, however, about a fortnight later in duration and will

be transferred for trial to the next higher duration group next season. Besides these varieties superior to control, there were 11 other varieties as good in yield as the respective controls and would be further tested next year.

(ii) Hybridization—

(*a*) *Between japonica and indica rices.*—Hybridization between *japonica* and *indica* rices was continued according to schedule, under the schemes sponsored by the F.A.O. and the Indian Council of Agricultural Research at the Institute. These two schemes, as previously reported, have been undertaken in order to provide breeding material to several South and South-East Asian countries and the rice growing States of India, for evolving strains which combine the high yielding ability and good response to intensive manuring characteristic of the *japonicas* with the hardiness and adaptability to tropical conditions of the *indica* rices.

During the year 6088 crossed seeds were obtained and hybrids of 57 cross combinations were back-crossed to the respective *indica* parents. For growing the F_2 and BC_2 generations approximately 7·8 lakhs and 6100 seeds respectively were distributed in India and South-East Asian countries participating in the schemes. The original hybridization programme, in both the schemes, has now been completed and the duration of the schemes has been extended to March, 1956 in order to provide for crossing of five additional *indica* varieties from each of the participating units with two new *japonica* varieties.

The F_3 generation of 1,000 selections, made last year in the various cross combinations, was grown and studied under normal and heavily manured conditions. The normal manuring consisted of supplying 20 lb. N as ammonium sulphate plus 18 lb. P_2O_5 as super phosphate per acre over a basal dressing of 4,000 lb. green manure per acre, while heavy manuring consisted of 80 lb. N as ammonium sulphate plus 54 lb. P_2O_5 as super phosphate over a basal dressing of 8,000 lb. green manure per acre. In the field the plants were studied for flowering duration, ear bearing tillers, panicle character, fertility, vigour, lodging, etc., and based on these observations 4,800 field selections were made. In making these selections particular attention was paid to early maturity, panicle character and number of ear bearing tillers.

The yield performance of 498 of these F_3 cultures under normal and high fertility conditions was examined. The 498 F_3 cultures consisted of 280 lines derived from selections made in F_2 grown under normal fertility and 218 lines from F_2 grown under high fertility. The data are given below.

Performance of 498 F_3 *cultures under normal and high fertility conditions.*

—	Number of cultures showing.			
	No difference in yield between normal and high fertility conditions.	Decreased yield in high fertility.	Increased yield in high fertility.	Total.
F_3 cultures derived from normal fertility F_2.	59 (21·2%)	69 (24·6%)	152 (54·3%)	280
F_3 cultures derived from high fertility F_2.	45 (20·6%)	30 (13·8%)	143 (65·6%)	218
	104 (20·9%)	99 (19·8%)	295 (59·2%)	498

It will be seen that out of the 498 cultures more than half (59·2%) gave increased yields under high fertility conditions, while the remainder were about equally divided between cultures giving decreased yield under high fertility and cultures which behaved same under both the conditions. Further it would be seen that F_3 cultures derived from high fertility F_2 respond better to high fertility conditions than F_3 cultures derived from normal fertility F_2s. It may also be mentioned that some F_3 cultures, particularly those coming from BAM 12×*Omachi*, BAM 9×*Norin* 18,100 *Ramjawain*×Norin 22,—100 *Ramjawain*×*Aikoku*, 100 *Ramjawain*×*Taihoku* and T. 1145×*Taihoku* cross combinations, showed considerable yield increase under high fertility conditions.

The 4,800 field selections were studied in the laboratory for yield and fertility and 1,100 selections were finally retained. Each of the selections finally retained yields over 35-40 gms., some of them yield even over 100 gms., while the mean yield of the best *indica* parent is about 36 gms. A comparison of the mean yield of the selections in the F_2 and F_3 stages shows that in nearly all the cross combinations the mean yield of the F_3 selections was higher than that of the F_2 selections. The mean yield of the *indica* parents and some of the F_2 and F_3 selections are given in Table XIX. The F_3 field selections which yielded 30-35 gms. were bulked crosswise and are also being carried forward.

Forty five other *japonica-indica* cross combinations, in the F_2 generation were also studied during the year and 1597 field selections were made based on the similar criteria as employed for the F_3 generation. Of these field selections 860 have been finally retained based on yield and fertility.

TABLE XIX.

Performance of the japonica-indica *selections.*

Cross combination.	Indica parent	F_2 generation.		F_3 generation.	
	Mean Plant yield in 1953 (gms.)	No. of selections.	Mean Plant yield (gms.)	No. of selections.	Mean Plant yield (gms.)
GEB. 24×*Norin.* 1 . . .	21·2	51	30·1	41	56·0
GEB. 24×*Norin.* 6 . . .	21·2	24	31·3	25	56·6
GEB. 24×*Norin.* 23 . . .	21·2	5	40·2	17	45·7
GEB. 24×*Asahi.* . . .	21·2	47	44·0	36	45·0
GEB. 24×*Rikuu.* 132 . . .	21·2	36	37·0	35	48·0
GEB. 24×*Taichu.* 65 . . .	21·2	19	41·1	24	43·0
GEB. 24×*Taihoku.* 6 . . .	21·2	22	42·9	21	46·8
T. 90×*Aikoku.* . . .	20·5	18	38·6	16	41·5
T. 90×*Taichu.* 65 . . .	20·5	2	22·5	11	71·3
T. 1145×*Norin.* 36 . . .	27·4	30	49·2	35	48·8
T. 1145×*Asahi.*	27·4	23	38·8	37	45·9

TABLE XIX—*contd.*

Cross combinations	Indica parent	F_2. generation.		F_3. generation.	
	Mean Plan yield in 2953 (gms.)	No. of selections.	Mean Plant yield (gms.)	No. of selections.	Mean Plant yield (gms.)
T. 1145×*Taihoku.* 6 . . .	27·4	40	34·6	55	48·3
T. 1145×*Aikoku.* . . .	27·4	15	38·4	22	45·9
T. 1242×*Asahi.*	36·5	30	37·7	78	48·0
T. 812×*Asahi.*	22·0	17	45·5	47	47·0
BAM. 6×*Norin.* 36 . . .	34·2	22	43·6	29	48·1
BAM. 6×*Rikuu.* 132 . .	34·2	37	49·4	44	44·1
BAM. 6×*Taihoku.* 6 . .	34·2	25	41·4	24	43·0
BAM. 9×*Norin.* 18 . . .	29·0	43	32·5	54	55·1
BAM. 9×*Rikuu.* 132 . .	29·0	30	43·3	54	50·1
BAM. 11×*Taihoku.* 6 . .	31·8	20	42·2	39	47·4
BAM. 11×*Asahi.* . . .	31·8	19	34·6	21	44·7
Patni. 6×*Norin.* 1 . . .	18·3	8	32·6	17	44·5
Patni. 6×*Rikuu.* 132 . . .	18·3	18	31·2	28	41·8
H.S. 19×*Taihoku.* 6 . . .	22·8	7	31·9	20	57·4

(*b*) *Within indica group of rices.*—This breeding project, as previously reported, has been undertaken to evolve early maturing, high yielding strains. During the year 385 cultures in the F_4 generation, belonging to the following cross combinations were under study.

Cross combination.	No. of F_4 cultures.
T. 812×T. 1031	46
T. 1145×*Sathika*	61
T. 1145×China 2	46
T. 1145×T. 1031	132
T. 1242×*Sathika*	5
T. 1242×T. 1031	46
T. 90×*Sathika*	22
T. 90×T. 1031	22
BAM. 9×*sathika*	5
	385

T. 1145, T. 812, T. 1242, T. 90 and BAM-9 are the high yielding parents with duration ranging between 140 to 160 days and China 2, *Sathika* and T. 1031 are the early maturing parents with duration between 85 to 95 days and have low yields. The F_4 generation was studied in a replicated randomised layout with 4 replications, having single row plots of 26 plants each.

In yield though none of the cultures were found to be equal to BAM-9, the best of the high yielding parents, 11 of the cultures were, however, as good in yield as the remaining high yielding parents, *i.e.*, T. 1242, T. 90, T. 1145 and T. 812, while a number of others were as good as T. 90, T. 1145 and T. 812. From the point of view of maturity almost all these cultures were about a month earlier than the high yielding parents and a number of them were uniform in flowering duration. The data for the 20 best cultures are given in Table XX.

In the F_4 cultures under study 3,300 field selections, based on flowering duration and ear bearing tillers, were made. Out of these field selections. 243 from the 36 best cultures have been finally retained for study in the F_5 generation as shown below.

T. 1145×*Sathika*	83 selections.
T. 1145×China 2	7 „
T. 1145×T. 1031	86 „
T. 1242×*Sathika*	11 „
T. 1242×T. 1031	12 „
T. 90×T. 1031	18 „
T. 90×*Sathika*	25 „
T. 812×T. 1031	1 „
	243

It may be mentioned here that a number of the selections carried forward, particularly those from T. 90×T. 1031 combinations, are long and fine grained.

TABLE XX.

Performance of 20 best high yielding, early maturing cultures
F_4 generation

Culture.	Mean yield per plot (gms.)	Duration.	Remarks.
BAM. 9 (Parent) . .	712·1	160 days	Uniform for flowering.
T. 1242 (Parent) . .	5289·	155 ,,	,,
145-(T.1145×T. 1031) .	491·5	118 ,,	,,
T. 90 (Parent) . .	471·6	150 ,,	,,
13-(T. 1145×*Sathika*) .	453·1	140 ,,	,,
T. 1145 (Parent) . .	455·5	..	Not uniform for flowering.
366-(T. 812×T. 1031) .	435·9	133 ,,	Uniform for flowering.
72-(T. 1145×China 2) .	431·6	121 ,,	,,
14-(T. 1145×*Sathika*) .	417·7	121 ,,	,,
178-(T. 1145×T. 1031) .	413·5	120 ,,	,,
285-(T. 1242×T. 1031) .	411·5	..	Not uniform for flowering.
176-(T. 1145×T. 1031) .	409·5	120 ,,	Uniform for flowering.
363-(T. 812×T. 1031) .	407·5	..	Not uniform for flowering.
367-(T. 812×T. 1031) .	405·8	132 ,,	Uniform for flowering.
205-(T. 1145×T. 1031) .	404·9	118 ,,	,,
127-(T. 1145×T. 1031) .	403·0	122 ,,	,,
356-(T. 812×T. 1031) .	402·7	134 ,,	,,
110-(T. 1145×T. 1031) .	401·6	120 ,,	,,
76-(T. 1145×China. 2) .	399·9	119 ,,	,,
239-(T. 1145×T. 1031) .	399·9	118 ,,	,,
29-(*Sathika*×T. 1145) .	398·7	..	Not uniform for flowering.
6-(T. 1145×*Sathika*) .	396·8	124 ,,	Uniform for flowering.
9-(T. 1145×*Sathika*) .	393·4	..	Not uniform for flowering.
77-(T. 1145×China. 2) .	392·8	118 ,,	Uniform for flowering.
T. 812 (Parent) . .	325·0	145 ,,	,,
C.D.=	124·2		

III. Trial of Selections—

The performance of 13 selections, consisting of nine selections made in variety *Chinnamali*, two in variety T. 141 and two in variety *Kankisal*, was tested against their respective original bulks in a small yield trial. The results show that of the two selections in T. 141, selection T. 141-89 yielded significantly more than T. 141, while T. 141-84, though better yielding than T. 141, just failed to pass the significance level. Both these selections were significantly superior over all the other selections in the trial. None of the *Chinnamali* selections were significantly superior in yield than that *Chinnamali* bulk, though eight out of the nine selections yielded more than the bulk. Both the *Kankisal* selections significantly out-yielded *Kankisal* bulk. The yield data for the T. 141 and *Kankisal* selections are given in Table XXI.

TABLE XXI.

Performance of T. 141 selections.		Performance of *Kankisal* selections.	
Selections.	Yield lb./A.	Selections.	Yield lb./A.
T. 141-89 . . .	3,751·8	BHF 535 . . .	3,369·7
T. 141-84 . . .	3,648·5	BHF 439 . . .	3,321·5
T. 141 (Bulk) . . .	3,266·5		
Chinnamali Bulk . .	3,235·5	*Kanisal* Bulk . . .	1,989·5
C.D. . . .	385·5	C.D.	385·5

IV. Breeding for high fertility soil conditions—

The performance of 64 varieties was studied in order to determine their suitability for cultivation under heavily manured conditions. The varieties, grouped in 3 trials according to duration, *i.e.*, 105-115, 135-145 and 155-165 days, were grown under normal and heavy manuring. Normal manuring consisted of 20 lb. N as ammonium sulphate plus 18 lbs. P_2O_5 as super phosphate over a basal dressing of 4,000 lb. green matter per acre, while heavy manuring consisted of 80 lb. N as ammonium sulphate plus 54 lb. P_2O_5 super phosphate over a basal dressing of 8,000 lb. green matter per acre. The results obtained show that :—

(i) In all the three trials lower yields were obtained under heavy manuring and the depression in yield in the 105-115 and 155-165 days trials was significant as shown below.

Experiment.	Mean yield lb./acre		
	Normal manuring.	Heavy manuring.	C.D.
105-115 days duration	2,031·9	1,854·2	144·8
135-145 days duration	2,753·3	2,423·5	..
155-165 days duration	2,444·0	1,927·9	516·1

(ii) The interaction between varieties and levels of manure was not significant in 135-145 and 155-165 days trial, while in the 105-115 days trial the interaction was nearly significant and the yield of variety T.R. 3 in this trial was significantly depressed by heavy manuring, *vide* Table XXII.

TABLE XXII.

Interaction between varieties and levels of manure.

(105-115 days trial).

Variety.	Mean yield per plot in lb.		Difference. (M_2-M_1)	Difference. (M_1-M_2).
	Normal Manuring (M_1).	Heavy Manuring (M_2).		
M. 175-1	1·01	1·53	0·51	..
Zinya 149	1·78	1·81	0·03	..
K. S. R. 9	1·44	1·50	0·06	..
J. 6	0·94	0·97	0·03	..
PB. 1	2·17	2·46	0·29	..
14 *Son*	1·75	1·83	0·08	..
Mahlar No. 346	2·04	2·13	0·09	..
A. 64	1·53	1·63	0·10	..
P. L. R. 2	1·69	1·08	..	0·61
Ptb. 14	2·47	1·66	..	0·81
Kangni 27	1·72	1·49	..	0·23
T. R. 2	2·73	2·62	..	1·11
T. R. 3	2·09	1·17	..	0·92
Ramjawain 100	2·27	1·94	..	0·33
K. B. 1	1·89	1·11	..	0·78
Phulpattas No. 72	1·51	1·32	..	0·19
Lalnakanda No. 41	1·35	1·39	0·04	..
T. 21	1·24	1·58	0·34	..
N. 32	1·90	1·32	..	0·58
B. 76	2·81	2·63	..	0·18
Mean	1·82	1·66		
C. D. for interaction	0·84			
C. D. for levels of manure	0·13			

V. Breeding for non-lodging habit—

The local varieties are prone to lodging, particularly so under heavy manuring, resulting in loss in yield. As a preliminary step to introducing non-lodging habit in the local varieties, the performance of 16 varieties, selected

from the collection of genetic stocks, was investigated. The varieties arranged in two trials *i.e.*, 151-160 days and 171-180 days duration, were grown under normal (40 lb. N plus 18 lb. P_2O_5) and high fertility (120 lb. N plus 54 lb. P_2O_5) conditions. Variety *Puangnak* was found to be non-lodging under both levels of fertility and two varieties *i.e.*, A.C. 1951 and *Nam-dok-mai* did not lodge under normal fertility but did so to some extent under heavy manuring. The rest of the varieties lodged completely under both the levels of manuring. Since the non-lodging varieties were too late in maturing for Orissa conditions and not suited for direct introduction, they are being crossed to popular local varieties and the following crosses were made. Other crosses will be made during the coming crop season.

A.C. 1951 × Ch. 45
A.C. 1951 × BAM-9
Namdokmai × Ch. 45.
Ch. 45. × *Puangnak*.

VI. Breeding for disease resistance—

Work was initiated during the year for breeding strains resistant to blast and helminthosporium diseases suited to Orissa conditions. For execution of the breeding project and for study of the genetics of disease resistance the following parents are being used—

Co. 13 :—a *beali* variety—very susceptible to blast.
T. 608 :—a *laghu* variety resistant to blast.
T. 442 :—an early *aman* variety susceptible to helminthosporium.
T. 141 :—a *mid-aman* variety resistant to helminthosporium.
BAM-10 :—a late *aman* variety susceptible to blast but resistant to helminthosporium.
Co. 25 :—a very late *aman* variety resistant to blast but susceptible to helminthosporium.

The crossing programme is given below :—

(i) *Blast crosses.*

Co. 13 × Co. 25 for breeding short duration blast resistant strains and genetical studies.

T. 608 × Co. 25 for breeding medium duration blast resistant strains.

(ii) *Helminthosporium-crosses—*

T. 442 × T. 141 for breeding early and mid-*aman* strains resistant to helminthosporium.

(iii) *Combined crosses—*

Co. 25 × BAM 10 for breeding strains resistant to both blast and helminthosporium and genetical studies.

During the year the Co. 13 × Co. 25 cross combination was made.

VII. Secondary selections—

As has been previously reported, this investigation is in progress to study the scope of secondary selections in rice breeding. The study this year consisted of (*a*) trial of preliminary selections made in *Saruchinna*, a local cultivators' variety (*b*) trial of secondary selections made in Adt. 4 and (c) trial of secondary selections made in Adt. 20.

(*a*) *Trial of Saruchinna primary selections.*—As reported, 520 random field selections were made in *Saruchinna* last year. The performance of 99 of these selections, taken at random, was tested against the original bulk in a replicated progeny row trial during the year. Significant differences in yield were found between the progenies. Two of the progenies, *i.e.*, Nos. 32 and 73 were significantly superior in yield than the bulk, while seven were significantly inferior to it. The yield data of the 12 best progenies compared to the bulk are given in Table XXIII below.

TABLE XXIII.

Progeny.	Mean yield per plot (oz.)	% increase over bulk.
32	26·52	12·04
73	26·25	10·90
71	26·17	10·56
55	26·17	10·56
5	25·72	8·66
29	25·62	8·24
24	25·46	7·56
90	25·28	6·80
77	25·27	6·76
57	25·14	6·21
60	25·02	5·70
83	25·02	5·70
Bulk (control)	23·67	
C.D.	2·57	

Selections, based on number of ear bearing tillers, made in the above 12 progenies, are being carried forward for further study.

(*b*) *Trial of Adt. 4 secondary selections.*—Last year, as has been reported, no significant differences were found between the families, but in seven out of the 15 families tested there were significant differences in yield between the progenies. Further selections made in progenies of these families were therefore tested in a compact family layout. The yield differences between families were not significant and the differences in yield between progenies in all but one family were also not significant. Thus after two years of making the primary selections there was no residual variability left in the material and no further selections in Adt. 4 are being carried forward.

(*c*) *Trial of Adt. 20 secondary selections.*—Last year significant differences between the families as well as between progenies within six of the families were found. Selections carried forward from segregating families were tested in a compact family layout this year. No significant differences in yield between the families nor between progenies within any of the families except one family were found. Since there is no residual variability left in the material no further selections are being carried forward.

VIII. Genetics—

Spikelet Sterility.—As has been reported last year, the segregation for sterility in the F_2 of *japonica-indica* hybrids shows continuous variation, and irrespective of degree of sterility in the F_1 the range of sterility in F_2 families and the coefficient of variability was of the same order. This was confirmed this year by study of more F_2 families drawn from F_1s of different degrees of sterility.

Reciprocal crosses between MO. 2 and *Taihoku* show differences in sterility, being higher when *japonica* was used as the female parent. The reciprocal difference in sterility appears to persist in the F_2 generation, *vide* the data given below. Due to high sterility in the *Taihoku*×MO. 2 hybrid the population in the F_2 was very small.

Cross.	F_1 Sterility.	F_2 Population.	Mean Sterility F_2.
MO. 2 × *Taihoku* . . .	25·0 per cent.	795	52·7 per cent.
Taihoku × MO. 2 . . .	96·9 per cent.	18	66·1 per cent.

With a view to determine if there is association between sterility and other plant characters, F_2 families from several *japonica-indica* cross combinations were studied for plant height, flowering duration and tiller number. In all the cross combinations studied a significant negative correlation between plant height and sterility was found, the data are given below.

F_2 generation.	Population.	'r'.
Asahi × *Waner* 1	770	—0·2946
T. 1145 × *Taihoku*	390	—0·3067
MO. 1. × *Taihoku*	44	—0·6000
Taihoku × MO. 2	18	—0·3880

It would seem that plants resembling *indica* parent in being tall, tend to be more fertile than plants resembling *japonica* parent in being short and stunted.

As has been previously reported F_2 families originating from F_1s with different degrees of sterility were studied in 1952-53. In the F_3 generation, 196 families covering the range of variation in the sterility of F_2 generation of the cross combinations were studied during the year. The results show :—

(i) That irrespective of the sterility percentage of the F_2 parent, the majority of the plants in F_3 family had sterility below 40-50 per cent. and in general the fertility in the F_3 generation had improved.

(ii) The segregation for sterility in the F_3 families was continuous and the families could roughly be classed into two groups (*a*) families in which there was wide variation and (*b*) families in which the variation was small. No relationship, however, could be established between the segregation pattern in the F_3 and the

sterility percentage of the F_3 parent ; for example in two cultures of MO. 2 × *Taihoku* originating from F_2 plants having similar sterility (16·6 and 16·2 per cent) the variation in the F_3 in one case was wide ranging between 0-80 per cent. while in the second family the variation was more restricted, ranging between 0-60 per cent. with all except 6 per cent. of the plants below 30 per cent. sterility.

(iii) Among the F_3 families originating from highly sterile (80 per cent. or more) F_2 parents, the segregation was markedly towards fertility. However, in a few families the segregation was restricted towards high sterility, *vide* examples given in Table XXIV below.

TABLE XXIV.

Culture No.	Sterility percentage.											Total.
	F_2 Sterility.	0 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90	91 to 100	
JI.S.42	84·9	3	5	2	3	1	..	..	..	..	..	14
JI.S.44	89·8	1	3	3	2	..	..	1	..	..	..	10
JI.S.161	99·5	..	4	10	4	2	3	..	..	1	..	24
JI.S.162	99·6	..	2	4	7	6	2	..	..	..	..	21
JI.S.163	99·6	1	11	24	9	5	2	..	..	..	..	52
JI.S.41	81·4	..	..	..	2	..	2	2	2	2	..	10
JI.S.43	89·6	..	..	..	..	2	1	2	..	2	..	7

In one F_3 family (JI. S. 159), originating from F_2 parent with 96·6 per cent. sterility, the population consisting of 8 plants, segregated sharply into two groups of highly sterile and highly fertile plants.

Pigmentation.—Green leaf sheath was found to be simple recessive both to light purple and dark purple leaf sheath. The dark purple and light purple sheath differcence was found to be controlled by a single gene giving a segregation of 1 dark purple : 2 purple : 1 light purple sheath in the cross studied.

Dwarfs.—The dwarf mutant reported last year in the variety T. 1222 is apparently a simple recessive to the normal, this, however, remains to be confirmed. The mutant is characterised by profuse tillering, shortening of the panicle length, decrease in grain size and is a week later in flowering duration than the normal T. 1222. The relationship of the T. 1222 dwarf and other dwarf genes is being studied and an attempt is being made to exploit the profuse tillering habit of the dwarf for economic purposes.

IX. Physiology.

Photoperiod response of rice varieties.—This cooperative project has been undertaken at the instance of the FAO in collaboration with some South East Asian Countries, and response of 20 varieties assembled from 8 countries,

as shown below, is being investigated under photoperiods of $10\frac{1}{2}$, $11\frac{1}{2}$, $12\frac{1}{2}$ and natural day length.

Burma	2 varieties.
Ceylon	2 ,,
India	3 ,,
Indonesia	5 ,,
Malaya	2 ,,
Pakistan	2 ,,
Thailand	2 ,,
Vietnam	2 ,,

Ear emergence, commencement and completion of blooming, length of panicle, number of ear bearing tillers and plant height in the various treatments were recorded. The data are given in Table XXV below.

TABLE XXV.

	Early varieties. Photoperiod hours.				Late varieties. Photoperiod hours.			
	$10\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{1}{2}$	Control	$10\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{1}{2}$	Control.
Ear emergence (days)	57·4	63·2	71·3	95·7	91·2	107·8	149·4	138·0
Commencement of Blooming.	58·3	64·2	72·9	96·7	92·0	108·4	150·1	138·8
Completion of Blooming	69·6	75·8	82·8	106·2	101·2	115·3	158·3	143·8
Panicle length (cms.)	15·4	15·3	15·9	18·8	22·4	22·4	21·3	20·1
Number of ear-bearing tillers.	6·2	5·6	5·1	5·0	3·3	3·9	4·3	2·9
Height (cms.)	88·2	84·2	90·8	103·6	109·9	111·4	107·7	94·7

All the varieties included in the experiment were influenced by photoperiod and there is apparently no variety in this assemblage which is insensitive to photoperiod. Generally all varieties (whether early or late) tend to mature earlier with decreased day light as judged by the time taken for ear emergence. In $10\frac{1}{2}$ hours photoperiod ear emergence was the earliest. In the early varieties ear emergence was delayed with the increase in photoperiod but when compared to the control plants the ear emergence in all these photoperiods was very much earlier. In the late group the above behaviour generally holds good, the delay in $12\frac{1}{2}$ hours photoperiod compared to the control was due to the natural day length being less then $12\frac{1}{2}$ hours from about the middle of October. In one late variety, *i.e.*, *Gendjah Ratgi* from Indonesia, ear emergence under $10\frac{1}{2}$ and $11\frac{1}{2}$ hour photoperiods took longer time than the control plants, while it did not take place at all under $12\frac{1}{2}$ hour photoperiod and the plants died after the ear emergence in the control plants. Commencement and completion of blooming followed the pattern of behaviour of ear emergence. Panicle lengthand plant height of the early varieties appear to decrease under the photoperiod treatments as compared to the control and in case of late varieties both panicle length and plant height appear to somewhat increase.

CHEMISTRY.

I. Nitrogen Transformation in rice soils under water-logged state—

Laboratory studies in nitrogen transformation in low land soil, under water logged condition, undertaken in the previous year were continued. In water logged state of soil, a gradual transformation to and build up of NH_4-N was observed, and only traces of NO_3-N were found to be present during the period of water logging.

Nitrogen changes in the surface and sub-surface layers of the water logged soil were traced for a 10 week period of water logging. When nitrogenous fertilizers were applied as top dressing to the surface layer of the soil, complete recovery of added nitrogen could not be obtained either in ammoniacal or nitrate nitrogen form and losses were found to occur. Losses of added nitrogen from sulphate of ammonia were found to be about 20-30 per cent of the total added. With nitrate of ammonia fertilizer, however, the losses were considerably more, being about 60-65 per cent of the total added. In the later case, all nitrogen applied in the form of NO_3-N was destroyed and only traces could be detected after 4-5 days of application. This particularly made any NO_3-N fertilizer unsuitable for rice crop grown under swampy water logged conditions.

Losses of nitrogen from added fertilizers occurred during 5-7 days of application in water logged state, and were due to oxidising conditions in the surface layer of soil where NH_4-N, falling on surface was oxidised to NO_3-N, which got subsequently denitrified when leached down to the reducing sub-surface zone of soil.

Probable losses of nitrogen from added fertilizers by washing away of the same in surface drained waters were also estimated. With top dressed fertilizer in 1″-2″ of standing water, about 20-25 per cent of the added fertilizer remains in surface water after 48 hours of application. Even after 6 to 10 days of application, about 10 to 12 per cent of fertilizer still remains in the surface water and any heavy down-pour of rain occurring during this period is likely to result in substantial loss of fertilizer by washing away in surface run-off waters. Thus with top dressed fertilizer there is a two-fold loss of added nirtogen, amounting to about 20-60 per cent of total applied, depending on moisture conditions in the soil during and after applications.

These losses of nitrogen are, however, substantively reduced by sub-surface or deep application of ammonical fertilizer about 1″-2″ below the surface soil. NH_4-N thus added remains fairly stable in the sub-surface zone of the soil, and becomes gradually available to the crop. In Laboratory studies where nitrogen transformation with sub-surface placed sulphate of ammonia was traced for a 10 weeks period, practically no loss of added NH_4-N was detected. There was also no danger of loss in surface drained waters.

In a comparative study of two methods of fertilizer application under controlled laboratory conditions, where no loss due to surface drainage was allowed to occur, it was seen that with deep placement of fertilizer, top 5″ layer of soil had 25-30 per cent more NH_4-N than a similar layer of surface applied treatment. Besides, with deep placement, the fertilizer was distributed deeper down in the soil profile and the soil layer at the depth of 2″-5″ from surface contained considerably more NH_4-N as shown in Table XXVI below.

TABLE XXVI.

NH_4-N content of different layers of water logged soil, after 14 days fertilizer application (expressed as p.p.m. on oven dry basis).

Depth of Sampling.	Method of appplication of fertilizer.	
	Surface in 1″-2″ standing water.	Sub-surface application.
0-1″ . . .	35	37
1″-2″ . . .	22	28
2″-5″ . . .	20	31

Thus the laboratory studies conducted on nitrogen transformation under water logged state of soil, have definitely proved the superiority of sub-surface or deep application of ammoniacal fertilizer.

II. Mode of application of sulphate of ammonia fertilizer and its effect on crop yield and uptake of nitrogen by plant.

The beneficial effects of sub-surface placement of sulphate of ammonia fertilizer on yield of crop, have already been reported from the Institue in a series of trials conducted during the last 3-4 years and further trials conducted in this respect to study the effect on uptake of nitrogen by crop with different modes of fertilizer application are reported here.

Sub-surface or deep application of fertilizer at pre-planting and post-planting stages was compared with normal surface application in two trials conducted during the main and second crop season. Periodical samples of plants taken at random were also analysed for nitrogen uptake. Results are summarised in Table XXVII.

TABLE XXVII.

Sulphate of ammonia—Mode of application. Mean yield in lb. per acre and per cent N in plant.

Treatment.	Yield of grain.		Per cent N in plant (Main season crop only).	
	Main season T. 141 (150 days).	2nd Season PTB 10. (110 days.)	At Maximum tillering.	At flowering.
1. Control	2579 (100)	1697 (100)	1·20	0·87
2. Surface applied fertilizer at 20 lb. N. per acre.	2795 (107)	1896 (112)	1·23	0·90
3. Deep application at puddling, 20 lb. N. per acre.	3011 (117)	2125 (125)	1·40	1·33
4. Deep application as pellets 20 lbs. N. per acre 21 days after planting.	3191 (124)	2110 (124)	1·42	1·40
5. Deep application at puddling, 20 lb. N, per acre followed by deep placement as pellets 21 days after planting.	..	2148 (127)	..	..
C. D. at 5 per cent.	357 lb.	199 lb.		

In both trials conducted during the year, sub-surface (deep) application of fertilizer, whether done at the time of puddling or later on after planting in the form of pellets, was found to be superior to surface application and gave grain yield about 12-15 per cent more than the customary surface application. Nitrogen uptake by the plant and reserve in the leaf sheath was also found to be higher at all stages of growth with deep application of fertilizer.

III. Phosphatic Manurial Trials—

Phosphatic manurial trials to study the direct and cumulative effect of phosphatic fertilization on growth and yield of crop, already in progress for last few years, were continued. Experiment to try rock phosphates from Trichinopoly and Singhbhum was also conducted.

In a field trial under low land water-logged, clay soil conditions, continuous application of super phosphate for two years at 50 lb. and 100 lb. P_2O_5 per acre, has shown no advantage. A similar trial conducted this year, on an upland sandy clay loam soil, with a short duration variety, also showed no advantage due to phosphate application. In a pot experiment *in situ* however, where similar dressings of P_2O_5 have been applied continuously for last four years, increases in yield of grain were obtained, as last year, with 100 lb. P_2O_5 per acre application.

Trichinopoly and Singhbhum rock phosphates, tried at 100 lb. P_2O_5 per acre in a medium land, showed no advantage due to phosphate application.

IV. Minor Elements Spraying Trials—

Spraying trials on growing crop with CuSO. and $ZnSO_4$ conducted during the previous year had shown some advantage ; trials with these two chemicals each at 10 lb. per acre sprayed once, twice and thrice at different stages of growth of crop, were therefore conducted this year at two locations with early and medium duration crops. No advantage due to spraying was observed. $CuSO_4$ spraying, however, gave slight increases in yield of grain, but these were not significant.

V. Miscellaneous Field Trials—

(*a*) *Seed soaking trials.*—Seed soaking trials were conducted at the instance of Institute of Plant Industry, Indore. Seed of variety T.141 (medium duration) was treated by them and sent to us for trials. Treated seeds were sown in nursery and transplanted as usual. None of the treatments were found significantly different from each other.

(*b*) *Seedlings* (*root*) *Soaking Trials.*—Roots of seedlings before transplanting were soaked for 12 hours in 5 per cent solutions of sulphate of ammonia and dipotassium hydrogen phosphate respectively to find the effect on yield and growth of crop. The treatments were not found to be significantly different from control.

(*c*) *Experiments with 'Montecol' Fertilizer.*—' Montecol' Fertilizer, invented specially for rice lands by Dr. Gonzalo Montemayer of Phillipines, was tried in a small scale trial with a medium duration variety of paddy and compared with sulphate of ammonia at 20 lb. N. per acre. ' Montecol ' fertilizer, used alone or in combination with other nitrogenous fertilizers, was not found superior to sulphate of ammonia.

VI. Analysis of Unoxidised Rice Soils—

Attempts are being made to work out and standardise rapid colorimetric methods of analysis suited for wet rice soil conditions. The routine methods of soil analysis developed for aerated and dry soils do not work satisfactorily, as the chemical nature of rice soil under water-logged state is materially different from that, when the same undergoes drying.

During the year, rapid colorimetric methods of determining ammoniaoal and nitrate nitrogen in unoxidised water logged soil have been standardised as the conventional methods failed to work due to presence of large amounts of ferrous and manganous ions in the soil extracts. The methods depend on separation of interfering ions and developing the colour in the routine manner with Nesslers' reagent for NH_4-N, and with brucine for NO_3-N. A larger number of fresh soil samples from wet rice fields can be handled with ease by these methods.

ENTOMOLOGY.

A. Field Pests.

I. Varietal susceptibility investigations.

(*a*) *Gall fly* (*Pachydiplosis oryzae*).—It has been reported previously that in general, incidence of gall fly is more in green non-scented varieties than in either the green scented or purple pigmented varieties. The large collection of genetic stocks at the Institute is now being examined for confirmation of this observation.

In the seedling stage no pest incidence was found in the genetic stocks ; however, in the transplanted crop gall fly incidence occurred and 524 early maturing varieties from the genetic stocks were studied and classified for susceptibility at the peak of incidence (November) of gall fly. The pest incidence in these varieties was found to range from 0 to 71·4 per cent as shown below.

Percentage incidence.	Number of varieties affected.
0	80
0·1 to 5·0	199
5·1 to 20·0	150
20·1 to 40·0	58
40·1 and above	37
	524

The silver shoots were silvery white in green varieties and purple in purple pigmented varieties.

(*b*) *Stem borer* (*Schoenobius incertellus*).—The relative susceptibility to stem borers of 88 *dalua* varieties was studied by examination of random samples at ' ear head ' stage. It was found that the percentage of white ear heads ranged from 1·58 (CH.51) to 43·75 (R.11. *Dubraj.*) and the varieties are classified into the following groups.

Percentage of incidence.	Number of varieties.
0·1 to 5·0	16
5·1 to 10·0	29
10·1 to 15·0	33
15·1 and above	10

(*c*) *Other pests.*—The varietal resistance to leaf hoppers (*Nilaparvata sordescens* ; *Nephotettix bipunctifer* and *N. apicalis*) was studied in an experimental plot with 14 varieties. It was found that the following Chinese varieties were severely infested.

Ch. 41, Ch. 2, Ch. 42, Ch. 43, Ch. 45, Ch. 47, Ch. 62 and Ch. 63. The following Indian varieties in the same plot showed very little hopper attack, Adt. 20, N. 136, Ptb. 10, B. 76-1, Adt. 4 and *Benibhog*.

Studies on the varietal resistance to rice ear head bugs (*Leptocorisa acuta* and *L. varicornis*) showed that the awned varieties are less susceptible than ownless varieties.

II. Incidence of pests in relation to agronomic practices.

With the object of detemining whether the incidence of pests depends on the age of the crop or the time of planting, 30 days old seedlings of two varieties, *viz.*, Ch. 45 and DI.4 were planted at fortnight intervals beginning from 12-7-1953, and ending on 22-2-1954. In all, sixteen plantings were done during the course of study.

(*a*) *Gall fly*.—Observations on tillering and incidence of gall fly were taken at two stages, 30 and 60 days after planting. The peak period of incidence (40·8 per cent) was noted to be from the second week of October to the end of November, and irrespective of the time of planting, 90 days old plants were found to be more susceptible than 60 days old plants. Natural parasitisation of the grubs of gall fly was first observed in the crop planted on 12th August and the highest percentage of parasitisation (89·1) occurred during November.

(*b*) *Stem borer*.—Stem borers cause damge during two stages of the crop, *viz.*, at early stage which results in dead-hearts and at the shot blade stage which results in white ear-heads. The incidence of stem borers started from October (1.04 per cent) and continued till March (26.69 per cent). The population of moths at light traps coincided with the incidence of stem borers. Highest percentage of white ear-heads was recorded in the plantings done during January and the highest percentage of dead hearts was noted in the plantings done in February. This indicates that the brood which emerged in February infested the standing crop, resulting in dead hearts in the crop planted in February and white ear-heads in the crop planted in January.

III. Insecticidal trials to control pests.

(*a*) *Gall fly*.—Trials for the control of gall fly by insecticides were carried out in a field experiment with BHC, DDT, a combination of BHC & DDT, and sweet flag. It was found that 0·2 per cent spray of a combination of BHC and DDT reduced the incidence by 12·1 per cent. Spraying an infusion of sweet flag did not prove effective against gall fly.

(*b*) *Stem borer*.—(i) Preliminary spraying experiments were conducted to find out the relative efficacy of three synthetic chlorinated hydrocarbon insecticides (BHC, DDT and Endrin) and four organo-phosphorous compounds (Folidol, Ekatox, Tetrax and EPN. 300). The results indcated that (1) Endrin 0·01 per cent was more effective than 0·2 per cent BHC or DDT, (2) Tetrax 1·0 per cent and Ekatox—0·1 per cent proved more effective than either Folidol-0·08 per cent or EPN-300—0·4 per cent. (ii) An experiment was designed to compare the efficacy of BHC and Folidol to control stem borers. The treatments consisted of pre transplanting treatments of seed soaking and dipping and post-transplanting treatments of spraying. The difference in borer incidence in the above treatments was not clearly brought out though it was indicated that 0·10 per cent Folidol spraying was more effective than 0·20 per cent BHC. In both cases spraying 5 times to synchronise with moth prevalance reduced borer incidence by 32·78 per cent and 18·18 per cent in Folidol and BHC treatments respectively. The results of this experiment need to be confirmed. (iii) In order to find out whether Folidol E. 605-E.C. can act as systemic insecticide, a preliminary experiment was laid out with the following treatments.

T_1—Check. Seed soaking in water for 24 hours.

T_2—Seed soaking in 0·10 per cent Folidol E. 605 for 24 hours.

T_3—Same as T_2 but followed by irrigating the seedlings in seed beds and the transplanted crop with 0·10 per cent Folidol at weekly intervals till flowering.

T_4—Same as in T_2 followed by spraying the seedlings in seed beds and transplanted crop with 0·08 per cent Folidol at weekly intervals till flowering.

Observations on tillering and growth of the plants were recorded at weekly intervals. At the time of harvest, counts of healthy ear heads and white ear heads due to borers were taken. The results indicated that seed soaking followed by irrigation (T_3) gave almost complete control of stem borers. Seed soaking did not affect germination and irrigation did not inhibit the growth of the plants.

IV.—Occurrence and control of other field pests.

Leaf hoppers were found infesting young transplanted crop in about nine acres of experimental plots during August. The hot and humid conditions 83·0°F temperature and 87·5 per cent humidity, during the middle of August appeared to be favourable for their outbreak.

The rice bugs were found in an epidemic form in about six acres of experimental crop from the middle of October to the middle of November. The temperature ranged from 80·5°F to 82·7°F and humidity from 80·6 per cent to 82·1 per cent during the period of their prevalance.

The leaf hoppers were effectively controlled by the following method (1) Dusting the crop with 5 per cent BHC at the rate of 20 lbs. per acre, (2) Draining off water from ill drained plots and letting in a clean stream of flowing water, (3) Applying ammonium sulphate as top dressing at the rate of 20 lbs. of nitrogen per acre to help the crop to recover from the ill effects of hopper damage.

The rice bugs were effectively controlled by dusting 5 per cent BHC or DDT at the rate of 10 to 15 lbs. per acre.

B. Pests of Stored Grain.

I. Insecticidal Trials to control pests in stored paddy.

During the previous year mixing one pound of sweet flag in 100 pounds of grain gave effective control of pests of stored paddy while dusting the surface of bags with sweet flag or BHC was less effective in this respect. To confirm the results, the experiment was repeated with the following treatments. Mixing 8 oz, 16 oz, 24 oz of sweet flag powder per 100 pounds of grain and dusting sweet flag and DO 24 (BHC) at the rate of 16 oz and 32 oz per 100 sq. ft. surface of the bags. The data showed that mixing sweet flag at the rate of 16 oz in 100 pounds of grain is the most effective and economic dose.

II. Insecticidal trial to control pests of stored rice.

The optimum dose of sweet flag required to control pests of stored rice was determined in a trial with the following treatments. Mixing 4 oz, 8 oz, 16 oz and 24 oz of sweet flag powder in 100 lbs. of rice. The results after storing for 12 months showed that mixing sweet flag at the rate of 16 oz in 100 lbs. of rice gave an effective control of pests of stored rice.

C. Laboratory Experiments.

The following new insecticides were tried against *Cirphis* (cut worm) and *Cnaphalocrocis* (leaf roller) :—Folidol E 605 EC (0·1 per cent), Ekatox (0·2 per cent), Tetrax (2·0 per cent), EPN-300 (0·4 per cent) and Endrin (0·01 per cent). *Cirphis* and *Cnaphalocrocis* larvae were first introduced on plants in cages and then the insecticides sprayed. The mortality was 100 per cent

in 3 hours in Folidol treated cage. The residual toxicity was studied by introducing fresh larvae every day on the same plants. Folidol E605 retained the toxicity for 4 days, EPN. 300 and Ekatox for two days and Endrin for one day only. Tetrax, however, had no residual toxicity.

MYCOLOGY

I. Study and estimation of resistance to disease particularly blast and 'helminthosporium' in the collection under genetic stocks.

The reaction of the types in the genetic stocks to the diseases commonly occurring at Cuttack was studied. Observations on disease incidence were made on all the types in the seedling stage, but later observations were confined to early varieties, nearly 450 in the collection. In the seedling stage blast was noticed on 78 varieties, out of which only 49 showed a susceptible reaction. Helminthosporiose was noticed only on two varieties. In the adult stage observation on early types, helminthosporium disease was noticed on 119 types, but only 13 showed a susceptible reaction. There was no blast. 'Leaf smut' was noticed on 87 types.

During the second crop season (December-April), 87 types selected for yield trials were kept under observation for studying their reaction to diseases. Though helminthosporiose was noticed on almost all the varieties in the seedling stage, only 19 showed a susceptible reaction. In the adult stage 36 were found to be susceptible. Blast was not seen in seed bed but in the observations made on adult plants, 14 were found to be susceptible.

II. Helminthosporium disease.

(i) *Tests of resistance of selected varieties under natural and artificial infection.*—The performance of six varieties, Ch. 13, Ch. 45, T. 141, Co. 20, T. 498-2-A and BAM.10, reported resistant last year, were tested under field conditions at Cuttack and in six states. At Cuttack they were subjected to artificial infection whereas in departmental farms of the states their reaction to the disease under natural conditions of infection was studied.

Artificial infection was carried out twice on each variety, once in the seed bed before transplanting and again at the time of flowering of the respective varieties. For seed bed infection an area of 1 sq. ft. was chosen at random under each variety and seedlings in that area were artificially infected. The remaining seedlings were used for transplanting.

The varieties were divided into three groups, *i.e.*, early, Ch. 13 and Ch. 45, medium, Co. 20, T. 498-2-A, and T. 141, and late BAM.10. A susceptible variety of each duration was used to flank the varieties under test (*Benibhog* early, T. 442 medium, S. R. 26B late). The varieties were planted in plots of $8' \times 5'$, each replicated five times. Plants in four of the replications were subjected to artificial infection with mycelial dust. Observation on disease development was taken a week after. The results confirmed that the varieties were relatively resistant to the disease.

Seeds of the varieties were also sent to Kashmir, U. P., Bihar, Assam, West Bengal and Andhra. In these states they were grown along with local susceptible types. Samples of diseased leaves or reports about occurrence were received from U.P., Bihar, Assam, West Bengal and Andhra. In all these states the five varieties Ch. 13, Ch. 45, T. 141, T. 498-2-A and BAM.10 remained resistant.

(ii) *Studies on the nature of disease resistance of rice varieties to helminthosporium disease.*—(a) In a study of the anatomy of infected leaves of

resistant and susceptible varieties, it was found that infection spreads laterally even across vascular bundles in the susceptible variety *Benibhog* whereas it was generally confined between bundles in the resistant varieties Ch. 13 and Ch. 45.

(b) A preliminary infection experiment was conducted with *Benibhog* (Susceptible) and Ch. 13 and Ch. 45 (resistant) to find whether the fungus takes a longer time to penetrate and show symptoms of infection in resistant as compared to susceptible varieties. After artificial infection the inoculum was allowed to stay on leaf surface for 2, 4, 8, 12, 24 and 48 hours. At the end of experimental period, the leaves were washed with water and fungicidal solutions. No differences could be noted between the varieties regarding time taken for penetration and development of infection. Infection was generally seen on leaves under 12 hours or more of contact with inoculum.

(c) Leaf extracts of susceptible and resistant varieties were inoculated with an isolate of *H. Oryzae*. There was no difference in the weight of mycelium produced at the end of 15 days incubation period. The growth rate also was uniform in agar media with leaf extracts of the susceptible and resistant varieties.

(iii) *Investigations on collateral hosts—Identification of pathogen and cross inoculation studies.*—Five isolates obtained from leaf spots on grasses resembling Helminthosporium leaf spot of rice, were used for inoculation on rice leaves. Four of them did not produce fruit bodies in the culture. One of them a species of Helminthosporium, resembled *Helminthosporium Oryzae* very closely. On inoculation on rice, four of them could penetrate rice leaves, but the infection did not progress beyond the penetration stage.

(iv) *Identification and estimation of air borne conidia over rice fields.*—Exposing greased slides in aeroscopes once a week for determination of aerial population of conidia of *Helminthosporium Oryzae* was continued throughout the year. The number of conidia of *Helminthosporium Oryzae* and other fungi trapped in each week was counted. Meterological data such as relative humidity, minimum and maximum temperature and amount of cloudiness for the days on which the slides were exposed were collected side by side. It was observed that increase in spore catch in any week was associated with increased humidity and cloudiness.

(v) *Seed treatment experiment.*—A field experiment on the seed treatment of rice for control of primary infection of Helminthosporium disease with four seed dressing fungicides, *i.e.*, (1) Agrosan GN, (2) Special Agrosan of low volatility (3) Fernasan A and (4) Copper seed dressing Y. F. 2776 was conducted during the year. The variety *Benibhog*, very susceptible to Helminthosporium disease was used. Seeds treated with the four fungicides were sown in the nurseries in a 5 × 5 latin square design. Observations on stand and disease incidence in five sample areas of 6″ × 6″ were taken per plot. Seedlings were then transplanted in a 5′ × 5′ latin square. Disease incidence at the adult stage was noted with reference to a standard chart. Yields of individual plots were noted.

Analysis of the data showed that though none of the treatments showed any significant difference with control as regards leaf infection in seedbed, infection in mature plants and in yield, one of the fungicides, *i.e.*, Special Agrosan was consistently associated with lower disease incidence and higher yield when compared to control and other fungicidal treatments.

III. Blast Disease..

(1) *Varietal susceptibility trials—*

(*a*) *Main Season trial.*—Out of nearly 450 varieties of rice, which have been under test during the last four years for their resistance to blast disease of rice, 148 varieties were chosen for a field trial under natural infection of blast. Each variety was sown in a small separate seed bed, and ammonium sulphate at the rate of 20 lb. N per acre was given about 15 days after sowing. Observations on disease incidence in seed beds were taken just before planting. Each variety was planted in two rows of 20 ft. length each flanked on either side by two rows of very susceptible variety, Co. 13. There were two replications. Ammonium sulphate at 60 lb. N per acre was applied about a month after planting. Observations on the incidence of foliar infection was taken before flower emergence. Observations on neck infection were taken shortly before harvest. On the basis of these observations 18 varieties were selected as resistant and 19 moderately resistant ; these have been carried over for further test next year.

(*b*) *Second crop trials.*—Fourteen early duration varieties out of the thirty seven mentioned above (including five resistant and nine moderately resistant varieties), were grown in the second crop season for studying their reaction to 'blast'. Two very susceptible varieties were also included. Artificial infections was carried out on one month old seedlings in seed beds and disease noted. After transplanting observation on leaf infection was recorded. The five resistant varieties (PTB 10, Ch. 55, B.J. 1, SM. 8 and R.I.A.R.I.) and two of the moderately resistant varieties (T. 6522 and H. 755) remained free from infection.

(2) *Control of blast by spraying fungicides—*

(i) *Efficiency of different fungicides.*—The treatments consisted of four sprayings each of (1) Bordeaux 5 : 5 : 50, (2) Perenox 0.31 per cent, (3) Coppesan 0.5 per cent, (4) Wetcol 0.31 per cent, (5) Dithane 0.2 per cent and control (unsprayed). The layout was rando mised block with one variety Co. 13 : there were 12 replications and area of unit plot was 40 ft. × 12.5 ft. One month old seedlings were planted on 29-8-53 and ammonium sulphate at the rate of 60 lb. N. per acre was given. Sprayings were done on 15 9, 28.9. 22.10 and 29/10. Observations on percentage of neck infection and yield were taken for each plot. Six random samples of 2 ft. × 2 ft. were selected from each plot. From each plant the number of tillers and number of neck infected tillers were counted and expressed as percentage of neck infected tillers. Yield for each plot was noted after leaving a border of one row all round. Analysis of the data showed that only one of the chemical treatments. *i.e.*, "Coppesan" was associated with a significantly lower pergcentage of neck infection than the control, though one per cent Bordeaux and Perenox 0·31 per cent had also brought down the neck infection to some extent. As far as yield was concerned, all the fungicides excepting "Wetcol", were associated with significantly higher yields than the control. Among the fungicides, "Coppesan" was assoiated with the highest yield giving an increase of 75 per cent over the control.

(ii) *Effect of time and number of sprayings of Bordeaux mixture (5:5:50) on blast incidence and yield of rice.*—In this experiment Bordeaux mixture alone was sprayed at different times and in varying number of sprayings to determine the time and number of spraying for effective cotrol of blast.

The treatments consisted of (1) four sprayings, two before and two after owering, (2) two sprayings, one before and one after flowering, (3) two sprayings,

both before flowering, (4) two sprayings both after flowering and control (unsprayed). There were two varieties Co. 13 and T. 1145. Lay-out of the experiment was a split plot with varieties as the main split and treatments second with eight replications. The size of unit plot was 29 ft. × 9·75 ft. The crop was planted on 21-8-53 and manured with ammonium sulphate at 60 lb. N per acre. Sprayings were given on different days between 4-9-53 and 30-10-53. Observations on the percentage of neck infection and yield per plot were taken in the same way as in the previous experiment.

Analysis of the data showed that in both the varieties, the percentage of neck infection in two of the treatments, four sprayings and two sprayings after flowering, was significantly less than the control. As regards the yield, there was a significant increase in yield over control only under four sprayings in the variety, Co. 13, whereas in T. 1145 all the sprayed treatments except four sprayings were associated with significantly higher yields.

(3) *Estimation of loss in yield caused by blast.*—Data on one of the varieties, T. 1145, from the previous experiment were utilised for the estimation of loss caused by blast. Correlation between the percentage of neck infection and yield per plot was determined. The regression of yield on percentage of neck infection was linear. From the regression equation the estimate of loss in yield per acre for every increase of one per cent of neck infection was found to be 24.46 lb.

IV. Physiological disease of rice.

A disease resembling 'PAN SUKH' a physiological disease of rice, was noticed during the season in the co-operative Chinese varieties trial at the Institute. Out of 15 varieties in the trial 10 were badly affected. Symptoms of the disease were yellowing and drying of leaves and stunting of affected plants. The root system in the affected plants was poorly developed and consisted of only coarse, thick roots or water roots which were discoloured. The fibrous roots which were abundant in healthy plants were rare in affected ones. Adventitous roots from upper nodes developed in the affected plants. There was a marked varietal reaction to the disease. Out of 15 varieties in the trial, two varieties, ADT. 4 and ADT. 20 were very resistant while *Benibhog*, B. 76-1 and PTB. 10 were moderately resistant to the disease.

The disease symptoms disappeared when the stagnant water in the fields was drained out and fresh water let in continuously for 48 hours. A light dressing of Ammonium sulphate at 20 lb. N per acre helped recovery.

FARM.

I. Multiplication of Improved Varieties.

During the year 2,220 mds. of seed of most popular strains of Orissa was produced for distribution.

II. Maximisation of Crop yield.

(a) The maximum yield experiment under high soil fertility condition was this year conducted under heavy and very heavy manuring with five varieties, *viz.*, T. 1145, T. 141, T. 90, T. 1242 and BAM.9. Heavy manuring consisted of application of 30 lb. N per acre, half applied as green manure and half as Ammonium Sulphate *plus* 72 lb. of P_2O_5 per acre, and very heavy manuring consisted of application of 110 lb. N per acre, 40 lb. given as green manure and 70 lb. as Ammonium Sulphate, *plus* 45 lb. P_2O_5. In both cases 400 lb. of lime per acre was applied. The maximum yield was again obtained with variety T. 141 (3728 lb. of grain and 7010 lb. of straw), very heavy manuring depressed the grain yield and increased the straw yield. The yield data are given in Table XXVIII below.

TABLE XXVIII.

Yield in lb. per acre.

Variety	Heavy manuring.		Very heavy manuring.	
	Grain	Straw	Grain	Straw
T. 1145	2,590	4,630	1,750	3,960
T. 141	3,728	7,010	3,663	6,390
T. 90	2,379	6,080	2,895	50,40
T. 1242	3,183	6,390	3,001	5,110
BAM. 9	2,578	6,850	*1,950	5,730

*Damaged by birds.

(b) *Maximum yield potential experiment.*—As previously reported, this permanent experiment is in progress to determine the extent to which yield can be stepped up by adopting all the departmental recommendations with regard to rice cultivation In the 4·8 acres reserved for this experiment *dhaincha* and *sunnhemp*, grown to supply 8,000 lbs. of green matter, were incorporated *in situ* in conjunction with 200 lbs. of super phosphate and variety BAM. 9 was planted in the last week of July An average acre yield of 3,402 lbs. of grain was obtained.

III. Cultural Trails.

(i) *Comparative efficiency of broadcasting sprouted seeds in puddle and transplanting.*—The performance of four *aman* varieties, *viz.*, T. 1145, T. 141, T. 1242 and T. 90 planted in the 1st and 3rd week of August was compared with the crop of these varieties raised from sprouted seed broadcast in puddle at 60 lb. per acre in 3rd week of July. The results indicate that broadcast sowing of sprouted seed in puddle was as good as the earlier planted crop in all the varieties except T. 1242. The data are present in table XXIX below.

TABLE XXIX.

Yield of grain in lbs. per acre.

Variety.	Planted crop.		Broadcast sprouted seed in puddle.
	1st week August.	3rd week August.	
T. 1145	3,041 (100·0)	3,237 (106·4)	3,376 (111·0)
T. 141	4,113 (100·0)	3,816 (92·8)	3,986 (97·0)
T. 90	3,115 (100·0)	2,807 (90·0)	2,972 (95·4)
T. 1242	3,606 (100·0)	2,714 (75·3)	3,226 (89·5)

(The figures in brackets give percentage yield on control).

(ii) *Effect of seed bed practices on the yield of the crop.*—In a preliminary experiment the yield of the crop from seedlings raised under (1) customary method, *i.e.*, broadcasting seed in the seed bed and covering with light plough and (2) dibbling the seed in the seed bed in the plough furrow was compared. The results obtained indicate that dibbling of the seed bed resulted in a better crop than broadcast sowing of the seed bed. 17 per cent better yield was obtained by this method, and the two methods of raising seed beds will be further tested next year.

(iii) *Effect of ridging on the yield of the crop.*—The effect of ridging on the yield and lodging of the crop was investigated in a preliminary trial with an *aman* variety Jelly-175. The ridging was done by hand about a month before flowering. It was found that while the non-ridged plots lodged badly, the ridged plots did not lodge and gave eight per cent significantly higher yield.

(iv) *Lodging in relation to yield of the crop.*—Preliminary studies on the effect of lodging on the yield of the crop was carried out with four *aman* varieties, *viz.*, T. 1145, T. 141, T. 90 and T. 1242, all of which lodge badly. In each variety in six random 3′ × 3′ squares, the plants were propped to prevent lodging and yield for these plants was compared with non-propped plants in similar random squares. Results obtained indicate that five to 48 per cent loss in yield was sustained due to lodging. The data are given in table XXX.

TABLE XXX.

Yield of grain in lbs. per acre.

Vareity.	Propped.	Non-propped (control).	Per cent increase on control.
T. 1145	2,590	1,750	148·0
T. 141	3,423	3,144	108·8
T. 90	2,762	2,418	114·2
T. 1242	3,172	3,011	105·3

(v) *Seed rate for broadcast and dibbled crops.*—Investigations on the optimum seed rates for broadcast and dibbled crops were continued with 40, 60, 80 and 100 lbs. of seed per acre. For the broadcast crop seed rate of 80 lbs. per acre was found to be the best, thus confirming the results of previous years. For dibbled crop 60 lbs. seed rate gave as good results as 80 lbs. seed rate. The data are given in Table XXXI.

TABLE XXXI.

Yield of grain in lbs. per acre.

	Dibbling seed rate.				Broadcast seed rate.			
	40 lbs.	60 lbs.	80 lbs.	100 lbs.	40 lbs.	60 lbs.	80 lbs.	100 lbs.
Yield .	2,462	2,725	2,765	2,640	2,485	2,446	2,674	2,502
Per cent on Control.	92·1	101·9	103·4	98·7	92·9	91·4	100·0	93·6

IV. *Intensive Cultivation Centre.*

Propaganda and demonstration of improved cultivation practices and distribution of seed were continued in the Intensive Cultivation Centre. The more important items of work done are given below :—

1. 1,005 mds. of high yielding rice strains, giving 10-15 per cent more yield than the farmer's varieties, were distributed.
2. Demonstrating the advantages of sowing rice mixed with *dhaincha* seed, the crop of the latter buried as green manure to the rice crop at the time of *beushening*.
3. Adopting economic seed rate of 80 lbs. per acre instead of the local rate of 100-120 lbs.
4. The benefits of adopting the practice of transplanting paddy wherever feasible for getting higher yields of the rice crop.
5. The benefit of fertilizing rice crop with 100 lbs. of Ammonium sulphate per acre and also the advantages of manuring potato crop with nitrogenous and phosphatic fertilizers.
6. The use of efficient mould board ploughs for preparatory tilling of rice soils and the labour saving implement, wet-land puddler.
7. The growing of *dhaincha* plants along the field bunds and/or allowing a few plants in the *beushened* field for seed purposes with a view to make the farmer self-sufficient for his seed requirement.
8. Educating the farmers regarding the need for maintaining nuclear pedigree seed pure and also how to maintain the purity of the seed by actual demonstration in their fields at the time of flowering of the crop and harvesting.
9. The method of compost making, distribution of seedlings of fruit trees, like lemon, orange, mango, etc., and the annuals like tomato.
10. Popularising the Japanese method of rice cultivation by actual demonstration in four centres for obtaining bigger yields.

TRAINING.

(i) *Refreshers' Course.*—A 23 days Refreshers' course, split up into 5 sessions of 3-4 days duration each between June 1953 and January 1954 in improved methods of rice cultivation, was held for the benefit of the Extension Staff of the Orissa Department of Agriculture and each session of this course was attended by 10-19 officers of the Department.

(ii) *Practical training for village level workers.*—Seventeen village level workers of the Kendrapara Community Project, Cuttack District, were given practical training for four days in rice cultivation.

(iii) *Pratcical training for Farmers.*—Seventeen farmers selected from the villages in the Intensive Cultivation Centre were also given practical training in rice cultivation for 3-4 days every month during the 1953-54 crop season, the total training period was of 21 days.

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Padmanabhan, S. Y., Ganguly, D. and Ballakrishnan, M. S. (1953).—Helminthosporium disease of rice-II. Source anddevelopment of seedling infection. *Ind. Phyto-pathology*. Vol. VI.

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Isreal, P. and Seshagiri Rao, Y. (1954).—Leaf Hoppers on paddy. *Rice News Teller*. Vol. II. No. 1.

Padmanabhan, S. Y. and Ganguly, D. (1954).—Relation between age of rice plant and its susceptibility to helminthosporium and blast diseases. *Proc. Ind. Acad. Sci.* Vol. XXXIX.

PROGRAMME OF WORK FOR 1954-55.

Agronomy Division.

I. Study of yield performance of different duration varieties.

II. Trial of varieties, suitable for double cropping.

III. To determine the suitability of various crops for growing in rotation with rice.

IV. Study of the relative efficiency of various nitrogenous fertilizers.

V. Study the response of rice to N, P and K nutrients and organic matter.

VI. Determination of the optimum dose, time and method of application of manures and fertilizers and their residual and cumulative effect on the soil fertility.

VII. To find the suitable alternative green manure crops for rice crop.

VIII. To determine the optimum time and method of green manuring of rice fields.

IX. Study of the efficiency of various herbicides for control of weeds in the rice fields and to determine the optimum concentrations and time of application.

X. Trial of small machines for rice cultivation and processing.

Botany Division.

I. Maintenance and study of genetic stocks including the FAO World Catalogue.

II. Maintenance of nucleus seed of improved strains.

III. Improving yield by
  (*a*) Introduction.—
  (*b*) Hybridization—
    (i) between *japonica* and *indica* rices ;
    (ii) within *indica* group for early maturity and high yield ;
    (iii) Yield and quality.

IV. Breeding for high fertility soil condition.

V. Breeding for disease resistance.

VI. Breeding for upland conditions.

VII. Breeding for non-lodging habit.

VIII. Study of secondary elections.

IX. Geneties
  Linkage group.
  Junctura less, auricleless mutant.
  Blast resistance·
  Non-lodging character.
  Sterility.
  Dwarf mutant.

X. Physiology
  Response of varieties to Photoperiod.

Chemistry Division.

I. Investigations on nitrogen transformation in water logged soil state and amelioration of conditions to make more nitrogen available to the crop.

II. Standardisation of methods of analysis of unoxidised paddy soil and determination of available plant nutrients under water logged state.

III. Investigations on direct and cumulative effect of phosphatic fertilizers and lime on growth and yield of crop and study of mechanism of phosphate availability under water logged condition.

IV. Placement technique of nitrogenous and phosphatic fertilizers.

V. Investigation on the effect of growth promoting substances on the growth and yield of crop.

Entomology Division.

I. Study of reaction of World Genetic Stocks to pests with a view to isolate resistant strains to insect damage (*sarad* and *dalua* varieties).

II. Varietal susceptibility and agronomic practices in their relation to pests in general and borers and gall fly in particular.

III. Estimation of loss due to pests particularly, *Schoenobius*, *Pachydiplosis* and *Leptocorisa* in the field.

IV. Effect of gall fly and stem borer attack on tillering and yield.

V. Studies on gall formation in paddy.

VI. Seedling treatment to control gall fly, leaf hoppers and stem borers.

VII. Insecticidal trials to control pests in the field.

VIII. Incidence of stem borers in relation to spacing.

IX. Japanese Method of Cultivation and incidence of pests.

X. Efficacy of low volume spraying.

XI. Investigations on the utilization of indigenous plant products as insecticides.

XII. Studies of alternate hosts of major pests of paddy.

XIII. Collection of indigenous parasites with a view to utilising them for biological control of pests of paddy.

XIX. Efficacy of aluminium bin for storage of paddy.

Mycology Division.

I. Study and estimation of resistance to diseases in fields of the collection of types under genetic stocks.

II. *Helminthosporium disease*—

(*a*) Tests of resistance of selected varieties under artificial and natural infection.

(*b*) Co-ordinated trial of selected resistant varieties in different States of India.

(*c*) Artificial infection tests on early types in genetic stocks for selection of resistant types.

(*d*) Identification and estimation of air-borne conidia over rice fields.

(*e*) Breeding resistant varieties : Study of the resistance of F1 plants of crosses made during 1953-54.

(*f*) Studies on the nature of disease resistance of rice varieties.

III. *Blast disease*—

(*a*) Tests of resistance of selected varieties under natural infection in field experiments.

(*b*) Co-ordinated trial of selected resistant varieties in different States in India.

(*c*) Artificial infection tests on early types in genetic stock for selection of resistant types.

(*d*) Breeding resistant varieties : Study of resistance of Fls of crosses made during 1953-54.

(*e*) Control of blast by spraying.

IV. Seed treatment of rice with fungicides.

Farm Division.

I. Multiplication of improved paddy strains.

II. Determining the merits of the sowing practices namely (i) dibbling, (ii) broadcast sowing of sprouted seeds in puddle and (iii) transplanting under optimum conditions.

III. Determining the effect of ridging on (i) dibbled and (ii) transplanted crop.

IV. Investigation on the efficiency of the seedlings raised under different systems namely (i) Japanese method, (ii) dibbling seed behind plough furrows in the seed bed and (iii) customary practice of dry sowing.

V. Study of the factors connected with loss in yield due to lodging.

VI. Maximisation of crop yield by heavy manuring and under the improved method of cultivation.

VII. Enlargement of the extension work in the Intensive Cultivation Centre.

STAFF (1953-54).

Director	Dr. N. Parthasarathy, Ph. D. (London), F.N.I.
Agronomy Division.	
Agronomist	Dr. Moti V. Vachhani, B. Ag., Ph. D.
Statistician	Shri T. P. Abraham, M.A., upto 5-11-1953.
Research Assistant	Shri C. P. K. Nair, B.Sc. Agri., upto 26-1-1954.
Ditto	Shri S. R. Upadhyaya, M.Sc., upto 10-7-53.
Ditto	Shri M. S. Choudhury, B.Sc., Assoc. I.A.R.I., from 21-11-53.
Botany Division.	
Geneticist and Botanist	Shri R. L. M. Ghose, M.Sc., F.A.Sc.
Assistant Botanist	Shri W. T. Butany, B.Sc. (Agri.) Hons., Assoc. I.A.R.I.
Research Assistant	Shri L. R. Daiya, B.Ag.
Ditto	Shri R. K. Misra, M.Sc.
Ditto	Shri R. Seetharaman, M.Sc.
Chemistry Division.	
Assistant Chemist	Dr. C. T. Abichandani, M.Sc., Ph. D., A.R.I.C.
Research Assistant	Shri S. N. Patnaik, M.Sc.
Entomology Division.	
Entomologist	Shri P. Israel, M.A., F.R.E.S.
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Ditto	Shri Y. Seshagiri Rao, M.Sc.
Farm Division.	
Farm Superintendent	Shri M. Subbiah Pillai, B.A., B.Sc. (Agri.).
Research Assistant	Shri N. A. Parasuram, B.Sc. (Agri.).
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Mycology Division

Mycologist	Shri S. Y. Padmanabhan, B.Sc. (Hons.), M.A., Assoc. I.A.R.I.
Assistant Mycologist	Shri Durgadas Ganguly, M.A.
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MGIPC—M—9 AR/55—11-11-55—750.